

## **CLAIMS**

We claim:

1. A method of defining a route for a net in a design layout that has multiple routing layers, wherein the route has a plurality of segments, wherein a set of at least two routing directions are available for routes on a particular layer, the method comprising:

a) adaptively defining a shape based on the set of routing directions available on the particular routing layer;

b) using the defined shape to define the shape at the ends of segments of the route on the particular layer; and

c) using the route segments with the defined end shapes to define the route.

2. The method of claim 1, wherein adaptively defining the shape comprises adaptively defining the shape based on the required widths for the route along different routing directions available on the particular layer.

3. The method of claim 2, wherein defining the shape based on the required widths for the route comprises:

defining at least two half planes based on each required width for the route along each available routing direction; and

intersecting the half planes, wherein the intersection of the half planes defines the shape.

4. The method of claim 3, wherein defining the half planes comprises defining a data structure that defines each particular half plane by specifying one particular value.

5. The method of claim 3, wherein each segment of the route has an associated style that defines the shape of the segment, wherein the defined shape is used to define the associated style of the route segments.

6. The method of claim 1 further comprising:

a) for each specific layer of the layout, adaptively defining a specific shape based on the set of routing directions available on the specific routing layer;

b) for each specific layer of the layout, using the defined specific shape to define the specific shape at the ends of segments of the route on the specific layer; and

c) using the route segments with the defined shapes to define the route.

7. The method of claim 6, wherein the method routes one set of nets at a time, the method further comprising:

for each particular set of nets:

a) adaptively defining, for each specific layer of the layout, a specific shape based on the set of routing directions available on the specific routing layer;

b) using the defined specific shape for each specific layer of the layout to define the specific shape at the ends of segments of the route on the specific layer; and

c) using the route segments with the defined shapes to define the route.

8. The method of claim 1, wherein the layout is an integrated circuit layout.

9. The method of claim 1, wherein the routing directions include Manhattan directions.

10. The method of claim 1, wherein the routing directions include Manhattan and non-Manhattan directions.

11. A computer readable medium that stores a computer program for defining a route for a net in a design layout that has multiple routing layers, wherein the route has a plurality of segments, wherein a set of at least two routing directions are available for routes on a particular layer, the computer program comprising sets of instructions for:

a) adaptively defining a shape based on the set of routing directions available on the particular routing layer;

b) using the defined shape to define the shape at the ends of segments of the route on the particular layer; and

c) using the route segments with the defined end shapes to define the route.

12. The computer readable medium of claim 11, wherein the set of instructions for adaptively defining the shape comprises a set of instructions for adaptively defining the shape based on the required widths for the route along different routing directions available on the particular layer.

13. The computer readable medium of claim 12, wherein the set of instructions for defining the shape based on the required widths for the route comprises sets of instructions for:

defining at least two half planes based on each required width for the route along each available routing direction; and

intersecting the half planes, wherein the intersection of the half planes defines the shape.

14. The computer readable medium of claim 13, wherein the set of instructions for defining the half planes comprises a set of instructions for defining a data structure that defines each particular half plane by specifying one particular value.

15. The computer readable medium of claim 13, wherein each segment of the route has an associated style that defines the shape of the segment, wherein the defined shape is used to define the associated style of the route segments.

16. The computer readable medium of claim 11, wherein the computer program further comprises sets of instructions for:

- a) adaptively defining, for each specific layer of the layout, a specific shape based on the set of routing directions available on the specific routing layer;
- b) using the defined specific shape for each specific layer of the layout to define the specific shape at the ends of segments of the route on the specific layer; and
- c) using the route segments with the defined shapes to define the route.

17. The computer readable medium of claim 16, wherein the computer program routes one set of nets at a time, wherein the computer program includes sets of instructions that for each particular set of nets:

- a) adaptively define, for each specific layer of the layout, a specific shape based on the set of routing directions available on the specific routing layer;
- b) use the defined specific shape for each specific layer of the layout to define the specific shape at the ends of segments of the route on the specific layer; and
- c) use the route segments with the defined shapes to define the route.

18. The computer readable medium of claim 11, wherein the layout is an integrated circuit layout.

19. The computer readable medium of claim 11, wherein the routing directions include Manhattan directions.

20. The computer readable medium of claim 11, wherein the routing directions include Manhattan and non-Manhattan directions.

21. A method of defining a route for a net in a design layout that has multiple routing layers, wherein the route has a plurality of segments, wherein a set of at least two routing directions are available for routes on a particular layer, the method comprising:

a) for each of at least two available routing directions on a particular layer, defining an unroutable bloated region about a previously defined geometry on the particular layer, wherein the bloated region for at least two different routing directions are different; and

b) defining the route for the net by using at least one bloated region for a particular routing direction to determine the portion of the particular layer that is not available for route segments along the particular routing direction.

22. The method of claim 21, wherein defining the item's bloated region for a particular direction comprises identifying the bloated region based on the width of the route segment in the particular direction for the particular net.

23. The method of claim 21, wherein the bloated region is defined based on half of the width of the route segment in the particular direction for the particular net.

24. The method of claim 21, wherein defining the item's bloated region for a particular direction comprises identifying the bloated region based on the minimum spacing required between the item and a route segment in the particular direction for the particular net.

25. The method of claim 24, wherein the minimum spacing is the minimum spacing between the item and the closest edge of a route segment in the particular direction for the particular net.

26. The method of claim 24, wherein the minimum spacing is the sum of the minimum spacing between the item and the closest edge of a route segment in the particular direction for the particular net and an attribute related to the width of the route segment in the particular direction for the particular net.

27. The method of claim 26, wherein the attribute is half of the width of the route segment in the particular direction for the particular net.

28. The method of claim 24, wherein defining the bloated region for a particular direction on the particular layer comprises examining potential locations for placing a route segment in the particular direction about the particular geometry to identify locations that would result in the route segment being closer to the particular geometry than the required minimum spacing for the particular direction.

29. The method of claim 28, wherein the examining comprises placing a route segment in the particular direction at various locations about the particular geometry and identifying the locations that would result in the route segment being closer to the particular geometry than the required minimum spacing for the particular direction.

30. The method of claim 28, wherein the potential geometry is an original geometry, wherein examining potential locations comprises:

defining a new geometry by reducing the size of the original geometry,

placing a route segment in the particular direction at various locations about the new geometry,

identifying the locations that would result in the route segment being closer to the new geometry than the required minimum spacing for the particular direction;

defining a first bloated region from the identified locations; and

defining a second bloated region by expanding the first bloated region.

31. The method of claim 24, wherein defining the bloated region for a particular direction on the particular layer comprises using an analytical approach to identify the bloated region.

32. The method of claim 31, wherein using the analytical approach comprises:

- a) identifying a first bloated region by expanding the particular geometry by the required minimum spacing for the particular direction; and
- b) identifying a second bloated region by expanding the first bloated region by the dimensions of a route segment along the particular direction.

33. The method of claim 31, wherein using at least one bloated region for a particular routing direction comprises using the bloated region during a path search to determine whether an expansion along the particular routing direction is viable.

34. A computer readable medium that stores a computer program for defining a route for a net in a design layout that has multiple routing layers, wherein the route has a plurality of segments, wherein a set of at least two routing directions are available for routes on a particular layer, the computer program comprising sets of instructions for:

- a) defining, for each of at least two available routing directions on a particular layer, an unroutable bloated region about a previously defined geometry on the particular layer, wherein the bloated region for at least two different routing directions are different; and
- b) defining the route for the net by using at least one bloated region for a particular routing direction to determine the portion of the particular layer that is not available for route segments along the particular routing direction.

35. The computer readable medium of claim 34, wherein the set of instructions for defining the item's bloated region for a particular direction comprises a set of instructions for identifying the bloated region based on the width of the route segment in the particular direction for the particular net.

36. The computer readable medium of claim 34, wherein the bloated region is defined based on half of the width of the route segment in the particular direction for the particular net.

37. The computer readable medium of claim 34, wherein the set of instructions for defining the item's bloated region for a particular direction comprises a set of instructions for identifying the bloated region based on the minimum spacing required between the item and a route segment in the particular direction for the particular net.

38. The computer readable medium of claim 37, wherein the minimum spacing is the minimum spacing between the item and the closest edge of a route segment in the particular direction for the particular net.

39. The computer readable medium of claim 37, wherein the minimum spacing is the sum of the minimum spacing between the item and the closest edge of a route segment in the particular direction for the particular net and an attribute related to the width of the route segment in the particular direction for the particular net.

40. The computer readable medium of claim 39, wherein the attribute is half of the width of the route segment in the particular direction for the particular net.

41. The computer readable medium of claim 37, wherein the set of instructions for defining the bloated region for a particular direction on the particular layer comprises a set of instructions for examining potential locations for placing a route segment in the particular direction about the particular geometry to identify locations that would result in the route



segment being closer to the particular geometry than the required minimum spacing for the particular direction.

42. The computer readable medium of claim 41, wherein the set of instructions for examining comprises a set of instructions for placing a route segment in the particular direction at various locations about the particular geometry and a set of instructions for identifying the locations that would result in the route segment being closer to the particular geometry than the required minimum spacing for the particular direction.

43. The computer readable medium of claim 41, wherein the potential geometry is an original geometry, wherein the set of instructions for examining potential locations comprises sets of instructions for:

defining a new geometry by reducing the size of the original geometry,

placing a route segment in the particular direction at various locations about the new geometry,

identifying the locations that would result in the route segment being closer to the new geometry than the required minimum spacing for the particular direction;

defining a first bloated region from the identified locations; and

defining a second bloated region by expanding the first bloated region.

44. The computer readable medium of claim 37, wherein the set of instructions for defining the bloated region for a particular direction on the particular layer comprises a set of instructions for using an analytical approach to identify the bloated region.

45. The computer readable medium of claim 44, wherein the set of instructions for using the analytical approach comprises sets of instructions for:

a) identifying a first bloated region by expanding the particular geometry by the required minimum spacing for the particular direction; and

b) identifying a second bloated region by expanding the first bloated region by the dimensions of a route segment along the particular direction.

46. The computer readable medium of claim 44, wherein the set of instructions for using at least one bloated region for a particular routing direction comprises a set of instructions for using the bloated region during a path search to determine whether an expansion along the particular routing direction is viable.